What's cooking?

An assessment of the potential impacts of selected novel alternatives to conventional animal products

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Key findings

- **Globally, food systems are responsible for about 30 per cent of the current anthropogenic greenhouse gas emissions driving climate change.** Animal products—including animal emissions, feed, changes in land use and energy-intensive global supply chains—account for almost 60 per cent of food-related emissions, for a total of 14.5–20 per cent of global emissions.
- **Impacts of the growing demand for animal source foods (ASF) take place in a context of unsustainable farming methods and overconsumption, especially in middle and high-income countries.** Overall, production and consumption significantly contribute to climate change, air and water pollution, biodiversity loss, and soil degradation.
- **While ASF are an important source of nutrition, high intake of red and processed meat is associated with increased risk of non-communicable diseases.** ASF production has also been associated with public health risks such as zoonotic disease and antimicrobial resistance, and animal welfare concerns.
- **Novel plant-based meat, cultivated meat and fermentation-derived foods could be instrumental in reducing the environmental impacts associated with the production of many conventional ASF.** They also show promise for reduced risk of zoonoses and antimicrobial resistance, and can significantly reduce animal welfare concerns associated with conventional animal agriculture.
- **Further research is needed to understand the potential socioeconomic and nutritional implications of novel ASF alternatives.** Policymakers could also help maximize beneficial outcomes by taking steps to safeguard food security, jobs, livelihoods, social and gender equity and culture.
- **The degree of uptake of these novel alternatives will likely depend on their cost, taste and social and cultural acceptability and on how they are regulated.**
- **Governments have numerous policy options to explore and support the potential of novel alternatives, including support for (open-access) research and commercialization and just transition policies.**
- **If supported by appropriate regulatory regimes and governance instruments, novel ASF alternatives can play an important role, likely with regional differences, in a shift towards food systems that are more sustainable, healthier and less harmful to animals.**

Figure 1. Scope of the report

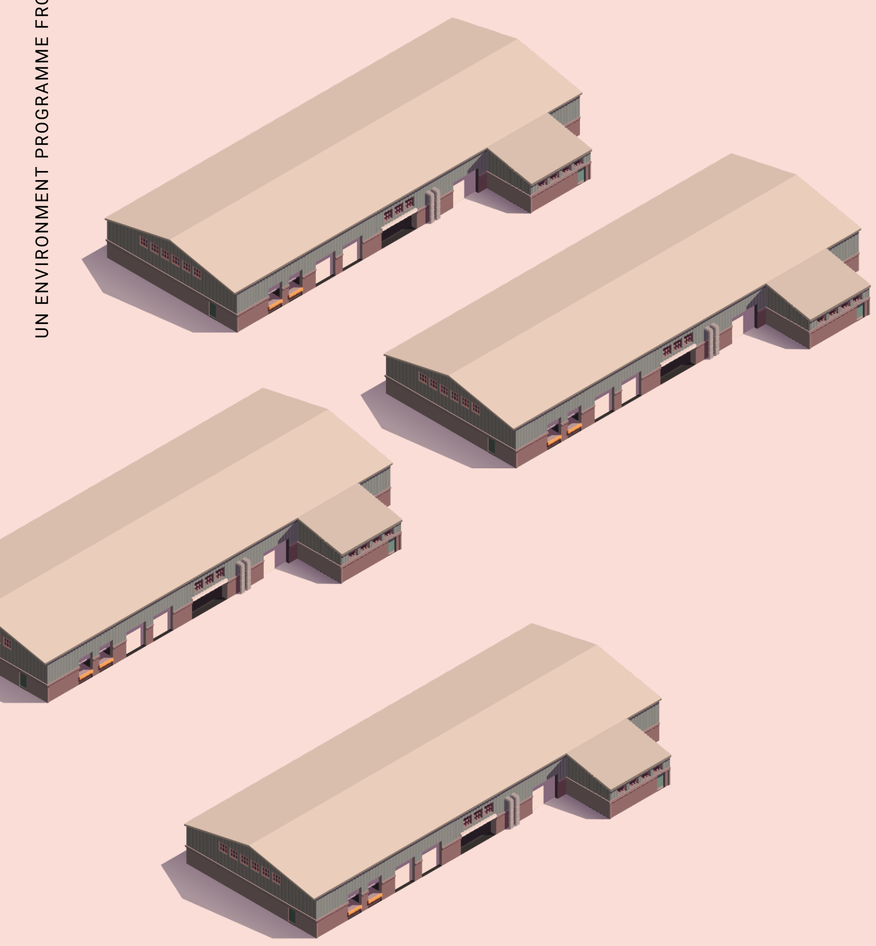
1. Introduction
2. Animal source foods significantly impact the environment, human health, socioeconomic dynamics and animal welfare
3. New technological solutions are being developed to provide an alternative to animal source foods
4. Policy and regulatory environments can significantly influence the future of alternatives
5. Conclusion

About this report

This report focuses on the potential environmental, health, social and animal welfare implications of the uptake of novel meat and dairy alternatives, in particular novel plant-based, fermentation-derived and cultivated products. A team of interdisciplinary experts has assessed the available evidence on the impacts of these alternatives in comparison with their conventional counterparts, identifying pertinent considerations for policymakers involved in regulating, investing in or providing other support for novel meat and dairy products and highlighting research gaps.

The report does not explore in depth how developing and shifting to novel alternatives compares with other strategies for reducing the negative impacts of the current meat and dairy industry, such as substituting meat and dairy with more traditional vegetarian and vegan products (e.g. tofu, tempeh), developing insects as a source of human and animal feed, promoting extensive and regenerative animal agriculture, reducing meat and dairy demand through pricing (e.g. meat taxes) or direct interventions to reduce animal emissions (e.g. feed additives). Neither does the report address fish and other aquatic animals, or meat from (other) wild animals.

Executive summary

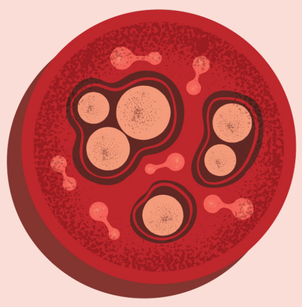


Globally, animal source food (ASF) contribute substantially to many countries' economies and are a major source of employment and income. They are also an important source of protein, vitamins, minerals and other nutrients, especially in food-insecure settings, and carry special significance for many demographic groups and cultures. At the same time, studies have generally found that high intake of red and processed meat is associated with increased risks of obesity and non-communicable diseases. Global production and consumption of ASF, including beef, pork, mutton, poultry and dairy have increased substantially in the last decades, with significant regional variations, as a result of population growth, rising incomes and generally supportive government policies, among other factors. Based on projected increases in population and per capita meat consumption, **current global meat consumption is projected to increase by 50 per cent or more by 2050 (notably with major regional differences).**

Animal agriculture, including animal feed production, is estimated to contribute 14.5–20 per cent of global human-caused GHG emissions, thus contributing significantly to human-induced climate change, as well as widespread air and water pollution, loss of soil structure and nutrients and loss of terrestrial, freshwater and coastal biodiversity. Furthermore, some livestock production systems have been linked to increased risk of zoonotic diseases and are associated with rising antimicrobial resistance. There are also animal welfare concerns as tens of billions of sentient animals are raised and slaughtered every year.

A number of approaches of varying feasibility and potential impacts have been proposed to address the environmental impacts of the livestock sector. These include investing in smaller-scale, extensive or regenerative livestock farms; direct interventions to reduce emissions from animal agriculture, such as feed additives; promoting reduced meat consumption in favour of whole plant sources of protein such as beans and lentils; and discouraging consumption of animal products with taxes or other policy levers. Thus far, such interventions have been limited, and are not achieving the desired impacts at the scale or speed necessary in the regions and amongst populations where such changes are most needed.

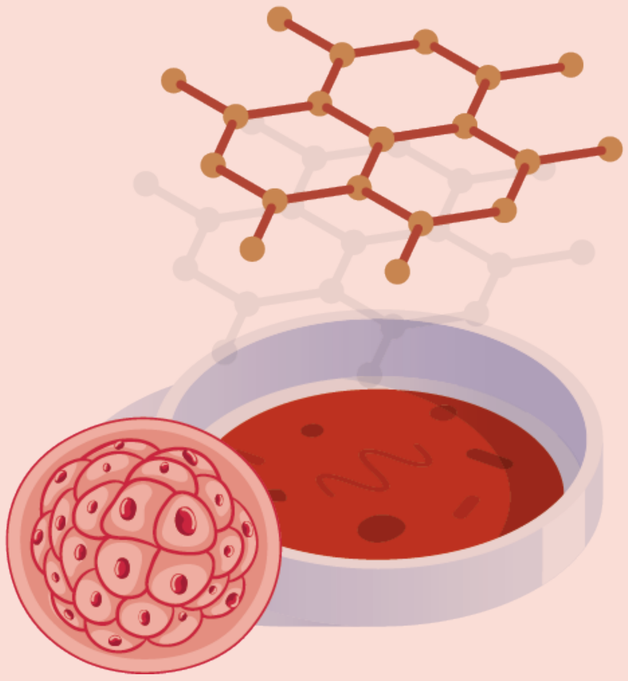
An additional approach that has attracted attention from policymakers and investors in recent years is to advance the development of novel alternatives such as novel plant-based, fermentation-derived or cultivated ASF products. These products have a sensory profile (i.e. appearance, taste, smell and texture) similar to or even indistinguishable from conventional ASF. These alternatives include:



- **Novel plant-based products,** made from plant protein (typically from soy or pea) combined with fats, vitamins, minerals and water to closely imitate the sensory profile of meat.
- **Cultivated meat,** which is real meat made from animal cells grown in bioreactors.
- **Fermentation-derived products,** including:
  - *Biomass fermentation-derived products,* which are protein-rich foods created using the rapid growth of microorganisms that are themselves the primary ingredients; and
  - *Precision fermentation-derived products*, which use microorganisms to produce ingredients, including particular proteins, flavours, vitamins and fats, to be added to a final food product.

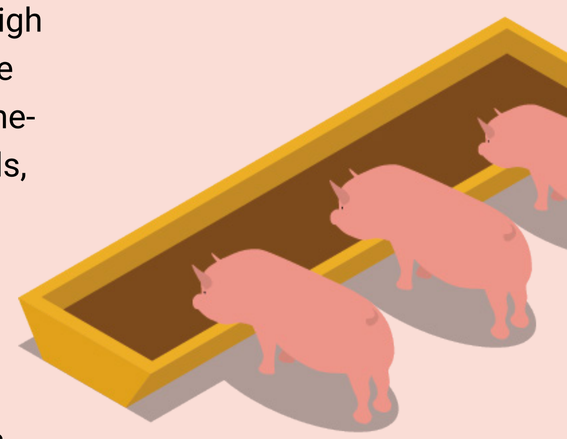
Forecasts for the growth of the novel meat alternatives industry vary widely. Projections for its share of total meat consumption range from 4 to 60 per cent by 2040, while projections for the market share occupied by each category of alternative also vary. This illustrates the inherent uncertainty of making predictions of uptake at this early stage of the industry's development. Significant technological advances are still required for these foods to become available at wider scale and to compete with conventional ASF on taste and price.

Assessing the environmental lifecycle impacts of novel ASF alternatives is difficult, as data is scarce, parts of the industry are not yet operating at scale and further developments are expected. **However, novel ASF alternatives already show strong potential for reduced environmental impacts compared to many conventional animal products.** From a GHG emissions perspective, the novel alternatives considered in this report compare especially favourably to beef, which is particularly high-emitting. Nevertheless, some novel products, including cultivated meat, can be energy-intensive to produce. Realizing their full emission reduction potential is therefore contingent on the use of low-carbon energy.



Targeted research is needed to comprehensively assess the public health implications of novel ASF alternatives as they develop. Both traditional plant-based foods and novel ASF alternatives are associated with reduced risk of zoonoses emergence and anti-microbial resistance. Diets that emphasize minimally processed, plant-based foods are generally associated with reduced risks of premature mortality and non-communicable diseases. However, novel plant-based products currently tend to be highly processed and have high amounts of salt, though opportunities to enhance their nutrient quality exist. Evidence on the health impacts of ASF alternatives using fermentation or cultivated from animal cells is limited.

Understanding the potential socioeconomic implications of novel ASF alternatives also requires further research. Nevertheless, it is clear that high uptake would disrupt current food systems with both positive and negative impacts for different stakeholders. Policymakers could help maximize beneficial outcomes by taking steps to safeguard food security, jobs, livelihoods, social and gender equity and culture.



ASF alternatives, including the novel forms discussed in this report, have the potential to drastically reduce harm to animals in the food system. Plant- and fermentation-based alternatives avoid the use of animals. Cultivated meat still involves the use of animals to obtain stem cells (through biopsies) and, in some cases, animal serum (for growth media). However, vastly fewer animals would be needed to support cultivated meat production, and companies are working towards eliminating the use of animal serum, with some proven successes.

The policy and regulatory environment for novel ASF alternatives is evolving rapidly, with many governments formulating and implementing new policies and policy instruments. Many countries and regions—including Brazil, China, the European Union, India, Israel, Singapore and the United States of America—have invested in the production of novel ASF alternatives. Some countries, including Australia, Brazil and Denmark, have provided incentives to producers, with tax exemptions, subsidies and support for energy and market development, while some countries, including China, India and the Netherlands, are also investing in research, human resources, curricula development and the promotion of sustainable practices in this emerging sector. In contrast, in 2023 Italy approved a draft bill that would ban production, import and export of food grown in laboratories, including cultivated meat.

Ways through which governments can support novel alternatives to become commercially viable include providing funding for research—in particular open-source research—and commercialization. Governments can also develop regulatory and approval frameworks that ensure food safety in a transparent and streamlined manner.

A shift away from unsustainable forms of production and consumption of conventional ASF and towards novel alternatives presents various uncertainties. Government decisions could facilitate increased environmental, social and health benefits through proactive policymaking to promote a just and sustainable transition. Governments could consider reducing and/or redistributing subsidies or other forms of support currently in place for industrial animal agriculture to ensure food prices reflect associated health and environmental costs.

International collaboration, including through joint research, development and harmonization of standards and international support, can also advance the uptake of novel alternatives, alongside other approaches for meeting global food security and nutritional needs.

Overall, novel ASF alternatives, if supported by appropriate regulatory regimes and governance instruments, can potentially play an important role in a shift towards food systems that are more sustainable, healthier and less harmful to animals, with likely regional differences. Equitable, evidence-informed policies are needed to ensure positive outcomes. Understanding of the implications of these technologies and their interactions with other environmental, health and social systems continues to evolve, highlighting the need for more research, especially open-source research. **Policymaking will benefit from additional independent assessments of the environmental, health and socioeconomic implications of novel food technologies, as well as a better understanding of which policies are most effective in regulating and/or promoting them, and in what geographical, socio-economic and, in some cases, cultural contexts they are best deployed.**